BOLT BERANEK AND NEWMAN INC

CONSULTING · DEVELOPMENT · RESEARCH

AFCRL-68-0056

AD 666444

A SEMANTIC ANALYSIS OF ENGLISH LOCATIVE PREPOSITIONS

Gloria S. Cooper

Contract Monitor: Hans Zschirnt
Data Sciences Laboratory

DDC

MAR 1 5 1968

C

Prepared for:

AIR FORCE CAMBRIDGE RESEARCH LABORATORIES
OFFICE OF AEROSPACE RESEARCH
UNITED STATES AIR FORCE
BEDFORD, MASSACHUSETTS

CAMBRIDGE   NEW YORK   CHICAGO   LOS ANGELES
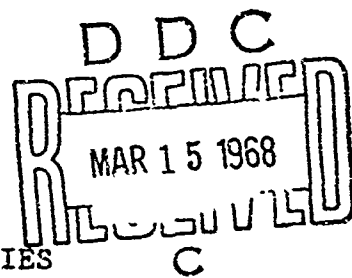
AFCRL-68-0056

A SEMANTIC ANALYSIS OF ENGLISH LOCATIVE PREPOSITIONS

Gloria S. Cooper

Contract No. F19628-68-C-0125
        Project No.   8668
        Task No.   866800
        Work Unit No. 86680001

Scientific Report No. 4

This research was sponsored by the Advanced Research Projects Agency
under Order No. 627

31 January 1968

Distribution of this document is unlimited. It may be released
to the Clearinghouse, Department of Commerce, for sale to the
general public.

Prepared for:

AIR FORCE CAMBRIDGE RESEARCH LABORATORIES
OFFICE OF AEROSPACE RESEARCH
UNITED STATES AIR FORCE
BEDFORD, MASSACHUSETTS

ABSTRACT

Locative prepositions are members of a small closed class of
English formatives. We present here an analysis of the thirty
three English locative prepositions in the context of a theory
which provides a basis for extracting semantic readings for
phrases containing these words.

The meaning of a preposition is first analyzed with function con-
cepts which pick out the relevant characteristics of objects to
be related. Then a relation concept is specified which describes
the special relation between the value of functions. The resulting
complex relation marker will thus have the form $R(f(x),g(y))$
where f and g are function markers, R is a relation marker, and
x and y are the objects to be related.

Report No. 1587   Bolt Beranek and Newman Inc

TABLE OF CONTENTS

SECTION I

INTRODUCTION

Locative prepositions are members of a small class of formatives
which are difficult to define. For example, try to distinguish
between "in the street" and "on the street" for a non-native
speaker of English. One is hard put to clear up the confusion.
It is interesting that native speakers, who often make all kinds
of syntactic and semantic errors never use prepositions in pre-
positional phrases incorrectly; while foreign speakers master the
proper use of prepositions with the greatest difficulty. It is
also interesting that children learn to use prepositional forms
as prepositions rather late in the language-learning game.

Prepositions may be viewed ·. linguistic representations of spa-
tial objects which are unique to a given language community.
Prepositions are differentiated from each other by mutually con-
trasting combinations of semantic markers.

A reading for a preposition consists of a complex semantic marker
which itself consists of a relation marker and function markers
operating on objects. The markers themselves are concepts re-
lating to the perceptual space viewed and occupied by speakers of
a language. As will be shown, the function markers extract, as
it were, a part of an object as semantically salient.

In this sense, speakers of a language must learn to attend to a
commonly shared inventory of perceptions. Speakers of the same
language are in agreement about the visual components of the
object world.   The listener is immediately cued by the speaker
to select one set of components for attention from a vast array

of possibilities. Prepositions represent a cognitive mapping of
a culturally contingent set of visual percepts. Nothing is
implied about how one learns to perceive; but, rather, what one
learns to perceive is a cultural dependent.

The difficulties encountered by foreign speakers can be accounted
for in two ways. First, the total set of locative markers is
different from language community to language community, but a
common core of such markers is found in all language communities.
Secondly, the minimal combination of markers which differentiates
one preposition from another within a given language, contains
different markers in another language. Thus, there will be
differences in the units themselves, and differences in combina-
torial possibilities from language to language.

Prepositions, then, provide a linguistic mapping of the object
world which is culturally habituated and thoroughly familiar to
all members of the same language community. It is this charac-
teristic of prepositions which can account for their later
acquisition by children. The young child must first learn the
cognitively significant semantic units for his own language. In
other words, he must first learn the markers of the system before
he can use the system. In this particular instance the markers
are complex, so that the child's learning task is two-fold. He
must learn the content of each marker in the total set of markers
for the language, and he must learn the combinatorial possibili-
ties of markers. How these two different learning tasks are
mastered is not known.

This theory proposes the set of semantic markers by means of
which English prepositions, as constituents of locative preposi-
tional phrases, enjoin speakers to conceptualize objects and
relations between objects. They are a set of learned discrimina-
tions which present a schema for perceiving and remembering.

This is not to say that the set of visual properties and
relations which give meaning to English prepositions are the only
ones available to English speakers. Obviously, English speakers
can be articulate about and can make many more discriminations
than the small set which mark prepositions. However, the diffi-
culty with which foreign speakers master correct usage of prepo-
sitions in contrast to other parts of the grammar suggests that
such speakers use a different set of semantic markers some of
which are common to all languages. Much of the difficulty is
semantic not syntactic. Foreign speakers are required to learn
a somewhat different set of visual features as well as somewhat
different combinations of such sets, some of which are very close
to the sets and lists encoded in their native language. Because
of this similarity, the learning task is very difficult.

For example, Spanish speakers learning English find it very hard
to differentiate between 'on' and 'over' or 'on' and 'above'.
The one Spanish phrase "la làmpara sobre la mesa" would be used
for the two events in English represented by "the lamp on the
table" and "the lamp above the table".

The Spanish speaker has no intuitive grasp of the difference be-
tween English "in" and "at", since both concepts are combined in
a single Spanish form.

English speakers learning German tend to say "Es gibt eine gute
Oper bei Lincoln Center" instead of "Es gibt eine gute Oper in
Lincoln Center". The semantic markers for "bei" and "in" are
somewhat different from the markers for English "at" and "in".

A serious concern of the psychology of perception has been with understanding how modifications in some properties of contours determine shape.   (Gibson, 1950) This too, is a separate problem to which this theory does not address itself.   For the purposes of this analysis, the shape of a closed contour is denoted by the noun which refers to it.   What this theory does propose is that all shapes that are named by nouns share some qualities in common.

A listener will make adjustments in his representation of the object to conform to the conceptualization of the object entailed by the preposition. This adaptability varies from speaker to speaker and is reflected in performance. Thus, some speakers will find a meaning for a seemingly bizarre phrase by accommodating to the requirements of the preposition.

SECTION II

DESCRIPTION OF THE VARIABLES

The semantic analysis presented here applies only to adverbials
of place used as modifiers of nouns. We will assume that the
meaning of these prepositions in other syntactic contexts
(e.g., as sentential modifiers) will be predictable from the
definitions we give here. The formal descriptions of locative
prepositions are components of the dictionary entries for these
lexical items. (Katz, 1966, p. 154). They are the "properties
of the formatives that are relevant for semantic interpretation."
(Chomsky, 1965, p. 87)

In any underlying structure containing the string

$$(- [Det + N_1]_{NP} + [Prep + (Det + N_2)]_{Adv-p} -)$$

we will let X be a variable for N_1 and Y a variable for N_2. We
assume that X and Y refer to objects, spaces or volumes that are
perceived or conceptualized as spatial wholes.

We will let Z be a variable for a space perceived as a figure
which stands in some relation to an X and Y. When Space is it-
self an object, it is a three-dimensional figure which replicates
in reverse much of the contour of the concrete object to which it
is contiguous. It is, as it were, a ghostly reflection of a
concrete figure. Thus, the edges and sides which are contiguous
to the concrete figure match in size the edges and sides of that
figure. But the edges furthest from the concrete figure are less
clearly specified and somewhat diffuse much as the reflection of
a building in a lake tends to diffuse at the outer edges.

Locative prepositions describe the spatial relations of physical
objects, areas, volumes, or spaces that are somehow perceived as
single figures. Thus, locative uses include such expressions as
"the book on the table", "the fly in the hole", or "the gap in
the mountain". A locative seems to function semantically in the
same way whether the referents of N_1 and N_2 are objects or spaces.
It seems reasonable to assume that these referents all have the
property of being unitary figures without concerning ourselves
here with how this happens.

SECTION III

DESCRIPTION OF THE MARKERS

The nature of the semantic description to be used may be summarized
as follows: a semantic marker is a formal symbol standing for a
concept. A list of primitive semantic markers is given, together
with a description indicating the intended interpretation of the
primitives. The definition of a word is then given by specifying
a complex semantic marker which is a combination of primitive
markers. The method of combination also has an intended inter-
pretation, so that the complex marker stands for a concept which
is composed, in the way indicated, from the primitive concepts.
For example, the marker (human) has as its intended interpretation
the property of being human. The marker (young) has as its
intended interpretation the property of being at the early part of
a limited temporal existence. Juxtaposition of markers has as its
intended interpretation conjunction of the properties of the
markers juxtaposed. Thus ((human)(young)) represents a complex
concept corresponding to the word "child". Semantic markers are
of (at least) two sorts. The examples given indicate concepts of
fixed properties. But a concept may also be of a relation with
two or more arguments, and these arguments may themselves be con-
cepts as well as other entities (e.g., physical objects or spa-
tial configurations). Thus, the concept of location is a relation
between two things, X and Y, and may be symbolized by the semantic
marker $L(X,Y)$. The intended interpretation is that Y is a place,
X is a physical object or a spatial configuration, and Y is the
location of X. As a special case of relation concepts we will
use function concepts. For example, we will introduce the primi-
tive semantic marker $1(\ )$, which is intended to correspond to the

concept of the following operator: if X stands for a physical
object or a spatial configuration, then i(X) stands for the
space or volume internal to X. A combination of relation markers
and function markers will have the usual interpretation. For
example, L(X, i(Y)) is to be interpreted as the relation L holding
between X and the value of the function i operating on Y. Thus,
L(, i()) is a complex semantic marker standing for the concept
of a complex relation.

Locative prepositions, unlike nouns and adjectives, specify rela-
tion-concepts with two or more arguments. Thus, in general, the
meaning of the prepositions must be given in terms of the relation
markers and function markers instead of the sort of marker which
specifies a property concept. Locative prepositions specify a
spatial relation between a small subset of the characteristics of
the objects indicated by the expressions which are connected by
the preposition. Thus, the meaning of the preposition can be
analyzed, first, with function concepts which pick out the rele-
vant characteristics to be related, and second, with the relation
concept describing the special relation between the values of the
functions. The resulting complex relation marker will thus have
the form R(f( ),g( )) where f and g are function markers and R
is a relation marker. For example, the complex marker L(,i( ))
described above gives the meaning of the preposition "in".

R, f and g will either be primitive markers taken from the list
given below or complex function and relation markers defined in
terms of the primitives. Semantic markers indicating properties
will be used only in selection restrictions which limit the
domain of the relations.

SECTION IV

THE MARKERS

1) L(X,Y) (Y is the LOCATION of X). L(,) is a two place
    relation which holds when Y is the location of X. Y may be
    either a precise location, or it may be a volume, area, or
    line which delimits the exact location of X. Thus, L(,)
    is intended to be the general concept of exact location. In
    this sense we can say that Mr. Jones' home is located in
    Cambridge.

2a) C(X,Y) (X is CONTIGUOUS with Y). C is a two-place relation
    which holds between X and Y when they are in contact, when
    they are adjacent, very close or in juxtaposition. The con-
    cept is applicable when the contact or closeness is over a
    considerable portion of both figures and not when the contact
    or closeness is at one point only.

2b) Sep(X,Y) (X and Y are not contiguous but separated). The
    contrast between contiguity and separation will be used to
    make the distinction between such prepositions as "on" and
    "near", "on top of" and "above". For example, if a pencil
    were located in the space above a table and were in contact
    with that table along that pencil's length (the pencil is
    lying on the table and so is contiguous with it) we would
    say the pencil is on top of the table. But, if the pencil
    were located in the space above the table without touching
    it (say, the pencil were suspended from the ceiling), we
    would say the pencil is above, but not on top of the table.

3) $\underline{S(X)}$ (S(X) is the set of points, lines and surfaces marking
the boundary of X). If X is a three dimensional figure
(i.e., a volume), S(X) is the set of surfaces enclosing or
marking off that figure. If X is two dimensional (i.e., a
surface), S(X) is the set of lines or the contour marking the
boundary or edge of the surface. And if X is one dimensional
(i.e., a line), then S(X) is the set of endpoints of the line.
In case X is a closed surface or closed line (and thus, not
having an edge or endpoints, as for example, a spherical
shell or a circle), then S(X) is empty. Clearly, S can be
iterated. If X is a box-figure, then S(S(X)) is the set of
lines forming the edge of the box. S(S(S(X))) is the set of
corner points of the box.

3a) $\underline{B(X)}$ (B(X) is the boundary of X). If X is two dimensional
B(X) = S(X). If X is three dimensional B(X) = S(S(X)). If
X is one dimensional B(X) = $\underline{nil}$. Thus, B(X) is the set of
lines marking the boundary or edges of an object, be it two
or three dimensional. It should also be noted that figures
will be marked for dimensionality (see Bierwisch) so that B
can actually be defined in terms of S as a function of X and
its dimensionality, without introducing any new concepts.

3b) $\underline{Sur(X)}$ (Sur(X) is the surface of X).
If X is three dimensional, Sur(X) = S(X)
If X is two dimensional, Sur(X) = X
If X is one dimensional, Sur (X) = X.

4) $\underline{Side_1(X)}$ (Side$_1$(X) $\equiv$ member of S(X)).

4a) $\underline{Top(X)}$ $(Top(X) \equiv$ member of $S(X)$ and $(+\ vert(X))$ and $(+ext(X)))$.
   $(+\ vert)$ marks the axis perpendicular to the side.
   The distinction between opposing sides which are considered
   a contrasting pair is indicated by a pair of markers called
   $(+ext)$ and $(-ext)$. (see Teller)

4b) $\underline{Bottom(X)}$ $(Bottom(X) \equiv$ member of $S(X)$ and $(+vert(X))$ and
   $(-ext(X)))$.

4c $\underline{Front(X)}$ $(Front\ (X) \equiv$ member of $S(X)$ and $(-vert(X))$ and
   $(+ext)))$.

4d) $\underline{Back(X)}$ $(Back(X) \equiv$ member of $S(X)$ and $(-vert(X))$ and
   $(-ext(X)))$.

4e) $\underline{Side_2(X)}$ $(Side_2(X) \equiv$ member of $S(X)$ and $(-vert(X)))$.

5a) $\underline{Distal(S(X))}$ $Distal(S(X))$ is a distance measure marking the
   farther $S(X)$ of two opposing $S(X)$'s from the point of view
   of a third referent, the speaker.

5b) $\underline{Proximal(S(X))}$ $Proximal(S(X))$ is a distance measure marking
   the nearer $S(X)$ of two opposing $S(X)$'s from the point of
   view of a third referent, the speaker.

6) $\underline{Sp(Z)}$ Z is a space defined by some relationship(s) to X
   and/or Y, the arguments of the prepositional relation.

SECTION V

DEFINITIONS OF THE PREPOSITIONS

1.) <u>X above Y</u>

X and Y are separate.	1) Sep(X,Y)
X is located internal to	2) Sp(Z)
the space Z, a bottom	3) L(X,i(Z))
boundary of which is	4) C(bottom(B(Z)),top(Y)) .
contiguous with the top of Y.	

This definition accounts for a range of positions an X may occupy
relative to a Y. It also accounts for differences which may
depend on changes in the visual field of the speaker. Since the
only condition on the relation between Z and Y is that any bottom
boundary of Z be contiguous with the top of Y, the bottom side of
the figural space Z may or may not coincide with the top side of Y.

In any stacked series of objects, the stack itself becomes the
space for any single object in it. Thus, one can talk about "the
stratum of oil above the other stratum", or "the red book above
the blue one." etc.

It is a fact of the world that objects which are gases and liquids
conform to the shape of the containers which confine them, or else
spread across the surface of another object. That is, their con-
tours are not inherently fixed. (This feature is syntactically
marked by mass nouns.) We view such objects as air, water, oil,
mist, fog, and the like, as filling the space Z such that they
may or may not be separate from the figure Y. Thus, phrases such

as "the air above the surface", "the mist above the trees", and
"the fog above the road" fit the definition given above.

Examples:

the plane above the city   the water above this level
the shelf above the desk   the pressure above the surface
the floor above this one   the atmosphere above the earth
the moon above the trees   the mist above the water
the mesa above the city

2.) X below Y

X and Y are separate   1) Sep(X,Y)
X is located internal to the   2) Sp(Z)
space Z, the top boundary of   3) L(X,i(Z))
which is contiguous with the   4) C(top(B(Z)),bottom(Y))
bottom of Y.

Examples:

the city below the plane   the water below the surface
the valley below the clouds   the oil below this level
the desk below the shelf   the book below the red one
the floor below this one   the pressure below the earth's
                                    crust

3.1) <u>X over₁Y</u>

                                 1) $Sep(X,Y)$

                                   2) $Sp(Z)$

                                   3) $L(X,i(Z))$

                                   4) $C(bottom(B(Z)),top(Y))$

    Over$_1$ is a synonym of above.

<u>Examples:</u>

the plane over the city   the gas over the surface

the shelf over the desk   the mist over the water

the floor over this one   the moon over the trees

the moon over Manhattan

3.2) <u>X over₂Y</u>

    SR: <X flexible solid or liquid> 1) SR: <X(flexible

        the back of X is contiguous   solid∨liquid)>

        with at least the top of Y   2) $C(back(X),top(Y))$

    Note that over$_2$ is not synonymous with above. SR indicates
    a selective semantic restriction.

<u>Examples:</u>

the blanket over the bed   the coat over the book

the blood over his hand   the frosting over the cake

the ivy over the fence   the water over the floor

Note that this definition optionally allows for the contiguity
of the back side of X with both the top and any other sides of Y.
Whether this is so or not depends upon the facts of the world
concerning X. If X is a flexible object, depending on its size
it may be folded in half, thirds or quarters, lengthwise, or it
may not. It may be small or very large. However to meet the
condition of the definition that the back side of X be contiguous
with at least the top side of Y, X must be similar in size to Y,
and can be larger.

At this juncture, we are not able to account for phrases such as
"the curtain over the window" meaning the curtain covering the
window. We can claim that it is a fact of the world that windows
do not have top sides, but are objects embedded in other surfaces
such as a wall or ceiling and are viewed as a part of such a
surface.

4.1) X under$_1$Y

X and Y are separate.	1) Sep(X,Y)
X is located internal	2) Sp(Z)
to the space Z, a top	3) T(Y,1(?))
boundary of which is	4) C(top(B(Z)),bottom,(Y))
contiguous with the	
bottom of Y.	

Under$_1$ is a synonym of below and antonymous to over$_1$ and above.

Examples:

the city under the clouds	the water under the surface
the desk under the shelf	the gas under the earth's crust
the floor under this one	the book under the red one
the chest under the mirror	the table under the umbrella

4.2) <u>X under$_2$Y</u>

	1) SR: <Y(flexible solid v
SR: <Y is a flexible solid or liquid>	liquid)>

    a surface of X is contiguous with

    an internal surface of Y   2) C(Sur(X),Sur(i(Y)))

    <u>Under$_2$</u> is an antonym of <u>Over$_2$</u>

    and is not antonymous with any

    reading of <u>Above</u>.

<u>Examples</u>:

the bed under the blankets	the streets under the flood-waters
the book under his coat	the tick under his skin
the vest under his jacket	the meat under the casing
the cut under the bandage	the face under the veil
the man under the sheets	the mummy under the bindings

5.1) <u>X underneath$_1$Y</u>

X and Y are separate.	1) Sep(X,Y)
X is located internal to the	2) Sp(Z)
Space Z, the top of which is	3) L(X,i(Z))
contiguous with the bottom of Y.	4) C(top(Z), bottom(Y))

<u>Examples</u>:

the desk underneath the shelf	the water underneath the
the chest underneath the mirror	surface
the floor underneath this one	the pressure underneath the
the trunk underneath the bed	earth's crust

Note that underneath$_1$ is almost synonymous with under$_1$. They
differ by the markers on Z. Underneath$_1$ selects the top of Z
as salient and under$_1$ selects a boundary of Z as salient. Thus,
for underneath$_1$ the space Z always coincides with the boundaries
of the bottom of Y, where this is not so for under$_1$.

5.2) X underneath$_2$Y

SR: <Y is a flexible solid
    or liquid>
    a surface of X is contiguous
    with the internal surface of Y

1) SR:<Y(flexible solid v
      liquid>
2) C(Sur(X),Sur(i(Y)))

Examples:

the bed underneath the blanket   the boy underneath the sheets
the book underneath his coat   the cake underneath the
                                       frosting

6.) X beneath Y

X is located internal to the   1) Sp(Z)
space Z, the top of which is   2) L(X,i(Z)) and
contiguous with the bottom of Y.   3) C(top(Z),bottom(Y))

Examples:

the desk beneath the shelf   the chest beneath the mirror
the floor beneath this one   the trunk beneath the bed
the city beneath the clouds   the boy beneath the sheets
the book beneath the coat   the vest beneath his jacket
the cake beneath the frosting   the cut beneath the bandage

-17-

Note that this is almost synonymous with underneath$_1$. Beneath$_2$
does not mark separation of X and Y, so that X and Y could be
contiguous or not.

7.) X against Y

SR: <Y is a solid>   1) SR:<Y(solid)>
    a vertical side of X is   2) C(side$_2$(X),side$_2$(Y))
    contiguous with a vertical
    side of Y

Examples:

the desk against the wall   the chair against the desk
the ladder against the house   the board against the fence
the car against the curb   the book against the back of
the rose hedge against the fence   the shelf
the puddle against the wall   * the ladder against the water
*the wall against the puddle   * the cliff against the fog

* = not permissible, because X does not meet the SR restriction

8.1) X is across$_1$Y

X is located in the space	1) $Sp(Z)$
which is contiguous with the	2) $L_1(X,Z)$
distal boundary of Y	3) $C(X,d(B(Y)))$

Examples:

the room across the hall	the chair across the room
the house across the park	the room across the house
the man across the street	the boat across the lake
the land across the sea	the letter across the table
the town across the river	the shoe across the floor

Across is ambiguous for location inside or outside a figure Y. Location internal to a figure has to do with facts of the world rather than a specification by the definition. For example, "the ball across the pool" is unspecified as to placement of the ball within the pool or outside the pool. All that is marked is that the ball is near the distal boundary of the pool from the point of view of the speaker.

It is a fact about the nature of houses that rooms are within them. This is not specified by the reading for the preposition.

8.2) <u>X is across$_2$Y</u>

SR: <A magnitude of X is equal to   1) SR:< $\geq$ (mag.(X),mag.(Y))>
or larger than a magnitude   2) C(X,d(B(S(Y))))
of Y>   3) C(X,p(B(S(Y))))
X is contiguous with the
distal and proximal boundaries
of a side of Y

<u>Examples:</u>

the rope across the bridge   the cable across the ocean
the log across the stream   the bridge across the river
the saucer across the cup   the crack across the wall
the bridge across the canyon

9.) <u>X by Y</u>

syntactic restriction   1) Sp(Z)
<Y is not an object pronoun>   2) L(X,i(Z))
X is located internal to the   3) C(Z,side$_2$(Y))
space Z which is contiguous
to a vertical side of Y

<u>Examples:</u>

the boy by my side   *the boy by me
the car by the road
the table by the door
the tree by the house
the house by the road
the trunk by the bed
the lamp by the side of my head

This definition is not marked for separation of X and Y.
Thus X and Y may or may not be contiguous.

10.) <u>X in back of Y</u>   This contrasts with <u>X in the back of Y</u>.

    X and Y are separate.   1) $Sep(X,Y)$
    X is located internal to the   2) $Sp(Z)$
    space which is contiguous with 3) $L(X,i(Z))$
    the back of Y   4) $C(Z,back(Y))$

<u>Examples:</u>

	in contrast:
the man in back of the house	the man in the back of the house
the opening in back of the house	the opening in the back of the house
the thread in back of the dress	the thread in the back of the dress

11.) <u>X in front of Y</u>

    X and Y are separate.   1) $Sep(X,Y)$
    X is located internal to the   2) $Sp(Z)$
    space which is contiguous witn 3) $L(X,i(Z))$
    the front of Y   4) $C(Z,front(Y))$

<u>Examples:</u>

	in contrast:
the man in front of the house	the man in the front of the house
the tree in front of me	*the tree in the front of me
the car in front of the house	the car in the front of the house

Examples: (cont.)

the yard in front of the school   the yard in the front of the
                                         school

the desk in front of the classroom   the desk in the front of the
                                         classroom

the glasses in front of the cups   the glasses in the front of
                                         the cups

12.) X beyond Y

    X and Y are separate   1) Sep(X,Y)
    X is located internal to the   2) Sp(Z)
    space which is contiguous to   3) L(X,i(Z))
    the distal boundary of Y   4) C(X,d(B(Y)))

Examples:

the street beyond this one   the road beyond the house
the man beyond the house   the car beyond the trees
the traffic-lights beyond the   the turn-off beyond the
  turn-off   traffic-lights

13.) <u>X in Y</u>

          \<X is smaller than Y>   1) SR:\<smaller(X,Y)>
            X is located internal to Y   2) $L(X,i(Y))$

<u>Examples:</u>

the elephant in the zoo	a bee in my bonnet
the flowers in my room	the papers in my desk
the drawer in my desk	the cigarettes in my pocket
the crack in the wall	the hole in his head

14.) <u>X out of Y</u>

              \<X is smaller than Y>   1) SR:\<smaller (X,Y)>
                  X and Y are separate   2) $Sep(X,1,(Y))$

<u>Examples:</u>

elephants out of the zoo	the flowers out of my room
the flowers out of my room	the papers out of my desk
the cigarettes out of my pocket	the coat is out of the closet
the coat out of the closet	

15.) <u>X beside Y</u>

Beside derives from "by the side of" so that the readings
for each of the morphemes are combined. However, this is to
say that the construct side(Y) is to be read as side(SIDE).
In this analysis, the side of SIDE is equivalent to side.

<u>Examples:</u>

the boy beside me = the boy by my side
the car beside the road
the table beside the door
the tree beside the house
the house beside the road
the trunk beside the bed
the lamp beside my head = the lamp by the side of my head

16.) <u>X near Y</u>

X and Y are separate	1) Sep(X,Y)
X is located internal to the	2) Sp(Z)
space Z which is contiguous	3) L(X,i(Z))
with Y	4) C(Z,Y)

<u>Examples:</u>

the boy near me	the car near the road
the table near the door	the house near the road
the trunk near the bed	the lamp near my head

17.) <u>X behind Y</u>

X and Y are separate   1) Sep(X,Y)
X is located internal to the   2) Sp(Z)
space which is contiguous   3) L(X,i(Z))
with the back of Y   4) C(Z,bk(Y))

<u>Examples:</u>

the road behind the house   the man behind the curtain
the chair behind the desk   the table behind the door
the trunk behind the bed   the faucet behind the house
the shed behind the house

18.) <u>X on Y</u>

                                    1) SR<supports (Y,X)>
SR: <Y supports X>   2) C(Sur(X),Sur(Y))
    a surface of X is contiguous
    with a surface of Y

<u>Examples:</u>

the nose on his face   the picture on the wall
the desk on the floor   the car on the street
the book on the table   the blood on his hands
the fly on the ceiling   the paint on the wall

19.) <u>X off Y</u>

    the surface of X is separate   Sep(Sur(X),Sur(Y))
    from the surface of Y

<u>Examples</u>:

the picture off the wall
the book off the desk
the paint off the wall, etc.

20.) <u>X at Y</u>

    selective restrictions:
    <X is portable relative to Y, and Y is not a geopolitical area>
    at = <u>near</u> or <u>in</u>
    Note that the selective restrictions exclude the following:
   *The history book at the mystery book but The history book
   near the mystery book.

   *The man at New York but The man in New York.

21.) $\underline{X \text{ between } Y_1 \text{ and } Y_2}$

X is located internal to the   1) $Sp(Z)$

space Z which is contiguous   2) $L(X, i(Z))$

with a boundary of Y_1 and a   3) $C(Z, B(Y_1))$

boundary of Y_2 4) $C(Z, B(Y_2))$

Examples:

the chair between the desk and the chest

the plane between New York and Boston

the hall between the bedroom and the bathroom

the book between the bookends

the river between St. Louis and New Orleans

Note that separation of X and Y's is not marked, so that X in the
space Z could be in contact with one or both Y's as in the last
three examples.

22.) $\underline{X \text{ among } Y_1, \ Y_2 \text{ and } Y_n}$

X is located internal to the   1) $Sp(Z)$

space Z which is contiguous   2) $L(X, i(Z))$

with a boundary of Y_1, a   3) $C(Z, B(Y_1))$

boundary of Y_2 and a   4) $C(Z, B(Y_2))$

boundary of Y_n ...

         n) $C(Z, B(Y_n))$

Examples:

the girl among the flowers   the men among the boys

the papers among the books   the flowers among the trees

the weeds among the grass

23.) <u>X inside (of) Y</u>

| | 1) SR.<smaller(X,Y)> |
| SR: <X is smaller than Y> | 2) L(X,i(side$_2$(Y))) |

SR: <X is smaller than Y>
    X is located internal to a
    vertical side of Y

<u>Examples:</u>

the man inside the room   the papers inside the drawer
the letters inside the mailbox   the car inside the garage
the train inside the station   the crack inside the wall

24.) <u>X outside (of) Y</u>

    X and Y are separate   1) Sep(X,i(Y))
    X is located internal to the   2) Sp(Z)
    space Z which is contiguous   3) L(X,i(Z))
    with a vertical side of Y   4) C(Z,side$_2$(Y))

Note that the first statement of the definition of <u>outside</u> is
antonymous to the reading for <u>inside</u>. This means that all
phrases containing <u>inside</u> may use the antonym <u>outside</u>, but not the
converse, i.e., not all instances of <u>outside</u> may substitute the
antonym <u>inside</u>, unless they meet the conditions of the selective
restriction for <u>inside</u>.

<u>Examples:</u>

the man outside the room   the light outside the house
the car outside the garage   the grass outside the yard
the elephant outside the window   *the elephant inside the window

25.) **X within Y**

    X "inside of" Y   1) S.R.<smaller(X,Y)>

                           2) $L(X,i(sd_2(Y)))$

Examples:

the man within the room
the furniture within the house
the children within the house

26.) **X around$_1$ Y**

                                 1) Sp(Z)

  SR: <X is a closed line or surface,   2) $X = S(Z)$

      or a collection of objects   3) $L(Y,i(Z))$

      which forms a closed line or

      surface>

      Y is located in the space

      which is inside (the closed

      line or surface) X

Examples:

the fence around the yard	the belt around his waist
the ring around her finger	the people around the table
the blanket around the boy	the wrapping around the box
the moisture around the dust particle	

Note that the reading for around$_1$ does not mark whether or not X
and Y are separate, so that X and Y may be in contact as in the
last three examples.

27.) <u>X up Y</u>

SR: <Y has a non-horizontal side>
    X is contiguous proximal to
    the top of a non-horizontal
    side of Y

1.) SR<Y has non-hside>
2) $C_p(X, S(\text{non-hside}(Y)))$

This definition does not account for phrases such as:

    the man up the street
    the house up the road
    the boat up the river, etc.

Since the marking of this use of 'up' seems to involve markers
other than those used for this analysis, such as (direction one
faces) or (path one traverses) namely markers of movement, it is
not being considered here. This definition will cover examples
such as:

    1) the cat up the tree (has been howling all day)
    2) the crack up the wall (is unsightly)
    3) the house up the hill
    4) the room up the stairs
    5) the pennant up the pole

Note this definition excludes bizarre phrases such as:

    *1) the cat up the floor
    *2) the dirt up the ceiling
       where Y is horizontal

28.) X down Y

SR: <Y has non-horizontal side>   1) SR:<Y has non-hside>
     X is contiguous proximal   2) $C_p(X,S(non-hside(Y)))$
     to the bottom of a non-
     horizontal side of Y.

Examples:

the hole down the tree   the room down the stairs
the crack down the wall   the house down the hill
the pennant down the pole

The following five prepositions are prepositions of direction
rather than locatives. They use a different set of markers for
which formal definitions have not yet been defined. They are
included here as an addendum even though their descriptions are
intuitive.

29.) X around$_2$ Y

     there is a pathway W that extends from one side of Y to
     at least one other side of Y and X is an endpoint on that
     pathway

Examples:

the store around the corner
the wagon around the back (of the house)
the house around the bend
the tree around the curve in the road

30.) <u>X around₃ Y</u>

there is a collection of places where X is located, which
are an indefinite number of points in the vicinity of Y

<u>Examples:</u>

the cats around the house
the children around the yard
the weeds around the garden

31.) <u>X about Y</u>

$= around_3$

<u>Examples:</u>

the cats about the house
the children about the house, etc.

32.) <u>X from Y</u>

There is a pathway W that has an origin point which is the
location of Y, and another point which is the location of X.
If X is a pathway, then $X \equiv W$. Otherwise, X and Y are separate.

One reading of nouns such as, 'road', path', 'ray', 'corridor',
and 'beam' must be semantically marked for (pathway).

<u>Examples:</u>

the light from the beacon   the book from the store

-32-

Examples: (cont.)

the paper from the cabinet   the road from town
the path from the house   the bus from New York
that man from England

33.) $\underline{X \ to_1 \ Y}$

There is a pathway W that has a terminal point which is the
location of Y, and another point which is the location of X.
If X is a pathway, then X ≡ W.

SR: <if X is a vehicle then it is the customary means of
        transportation for a given pathway>

Note that the following are bizarre:

*the roller-skates to New York
*the bicycle to Second Street
*the scooter to my house

but

the bus to town
the train to New York
the plane to Chicago
the steamboat to New Orleans
the boat to England

are acceptable.

ACKNOWLEDGEMENTS

REFERENCES

Bierwisch, Manfred. "Some Semantic Universals of German
    Adjectivals." Foundations of Language, Vol. 3, No. 1,
    February, 1967.

Chomsky, Noam. Aspects of the Theory of Syntax. MIT Press,
    Cambridge, Massachusetts. 1965.

Gibson, J. J. The Perception of the Visual World, Houghton
    Mifflin Company, Cambridge, Massachusetts. 1950.

Graham, E. "Visual Form Perception" in Vision and Visual
    Perception. Wiley and Company. 1965.

Katz, J. J. The Philosophy of Language, Harper and Row,
    New York and London. 1966.

McNeill, David. Developmental Psycholinguistics, Center for
    Cognitive Studies, Harvard University, Mimeo. 1965.

Teller, Paul. "Some Discussion and Extension of Manfred
    Bierwisch's Work on German Adjectivals", BBN Report No.1568,
    November, 1967.

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1 ORIGINATING ACTIVITY (Corporate author)	2a. REPORT SECURITY CLASSIFICATION
Bolt Beranek and Newman Inc 50 Moulton Street Cambridge, Massachusetts 02138	Unclassified
	2b. GROUP

3 REPORT TITLE

A SEMANTIC ANALYSIS OF ENGLISH LOCATIVE PREPOSITIONS

4 DESCRIPTIVE NOTES (Type of report and inclusive dates)

Scientific   Interim.

5 AUTHOR(S) (First name, middle initial, last name)

Gloria S. Cooper

6 REPORT DATE	7a. TOTAL NO OF PAGES	7b. NO OF REFS
31 January 1968	35	7

8a. CONTRACT OR GRANT NO ARPA Order No.627	9a. ORIGINATOR'S REPORT NUMBER(S)
F19628-68-C-0125	BBN Report No. 1587 Scientific Report No. 4
b. PROJECT NO ,Task, Work Unit Nos. 8668-00-01	
c. DoD Element 6154501R	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
d. DoD Subelement N/A	AFCRL -68-0056

10 DISTRIBUTION STATEMENT

Distribution of this document is unlimited. It may be released to the Clearinghouse, Department of Commerce, for sale to the general public.

11 SUPPLEMENTARY NOTES This research was sponsored by the Advanced Research Projects Agency	12 SPONSORING MILITARY ACTIVITY Air Force Cambridge Research Laboratories (CRB) L. G. Hanscom Field Bedford, Massachusetts 01730

13 ABSTRACT

Locative prepositions are members of a small closed class of English formatives. We present here an analysis of the thirty three English locative prepositions in the context of a theory which provides a basis for extracting semantic readings for phrases containing these words. The meaning of a preposition is first analyzed with function concepts which pick out the relevant characteristics of objects to be related. Then a relation concept is specified which describes the special relation between the value of functions. The resulting complex relation marker will thus have the form $R(f(x),g(y))$ where f and g are function markers, R is a relation marker, and x and y are the objects to be related.

DD FORM 1473 (PAGE 1)

S/N 0101-807-6811

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Semantics						
Linguistic theory						
Prepositions						
English language						